LIDAR: A Remote Sensing Tool for Determining Stream Channel Change?

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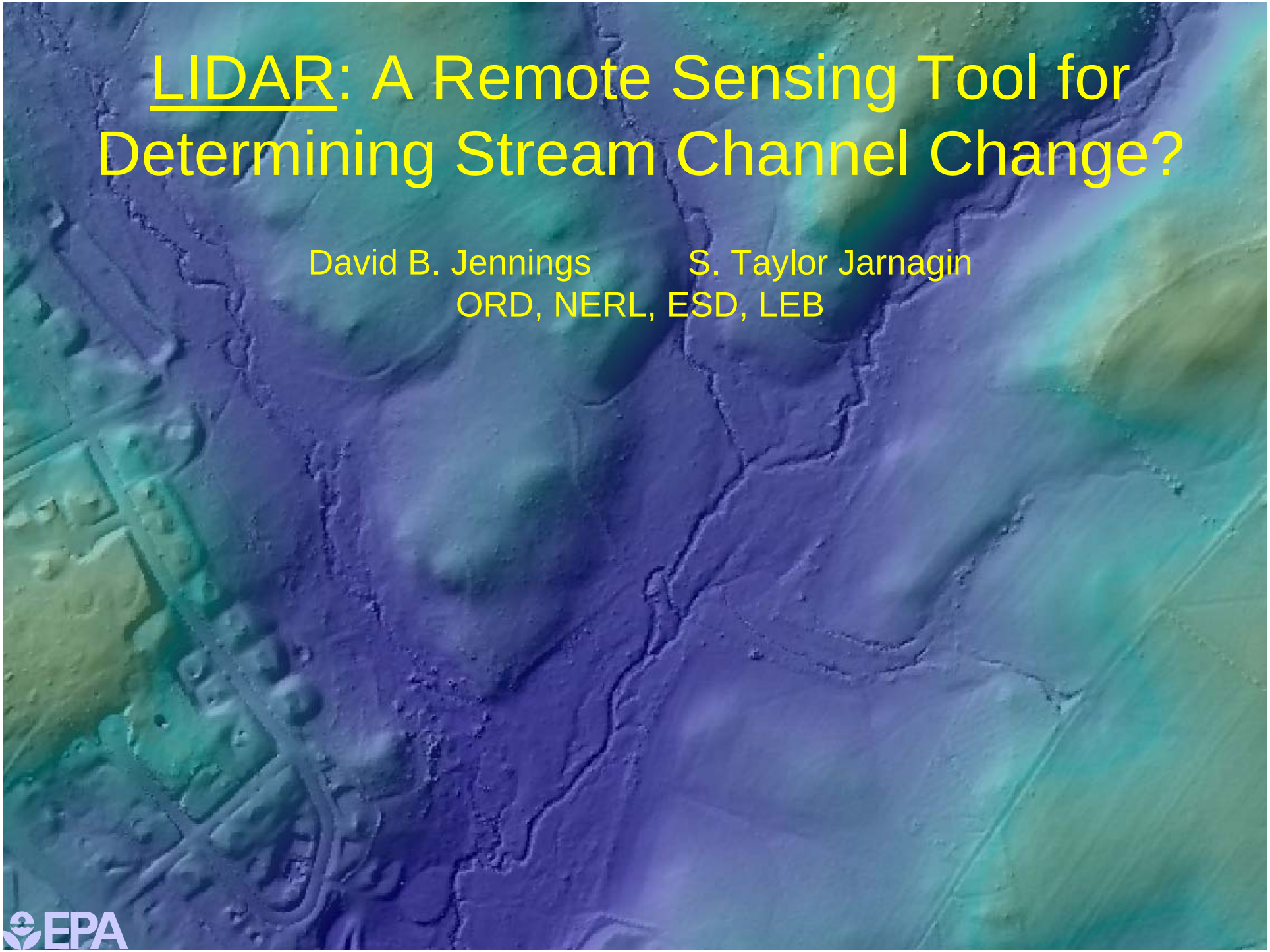
ORD, NERL, ESD, LEB



Overview

- Background on LIDAR
- Examples of topographic LIDAR
- Accuracies and Advantages of LIDAR
- A research application of LIDAR
  - Clarksburg Special Protection Area (CSPA), Montgomery County, Md.

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What is LIDAR ?

- **LI**ght **D**etection **A**nd **R**anging.
- LIDAR is an integrated system that utilizes:
  - A combination of positional systems to precisely determine sensor location and angle:
    1. **Airborne Kinematic GPS.**
    2. **Sensor dedicated Inertial Measurement Unit (IMU).**
    3. **Proximal ground-based static GPS survey data from a known Geodetic monument.**
  - A ranging system to determine the distance of the environmental object from the sensor.

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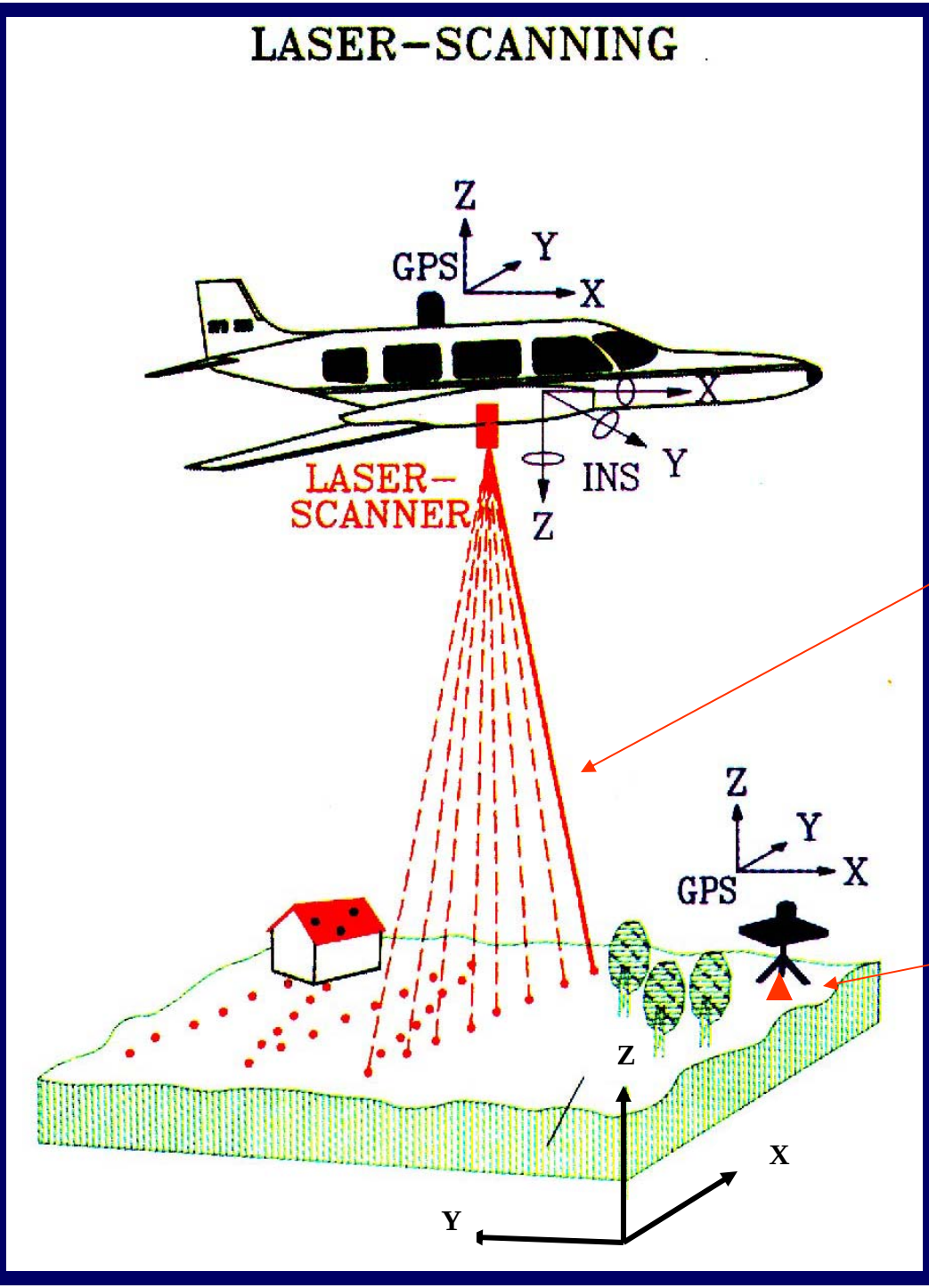
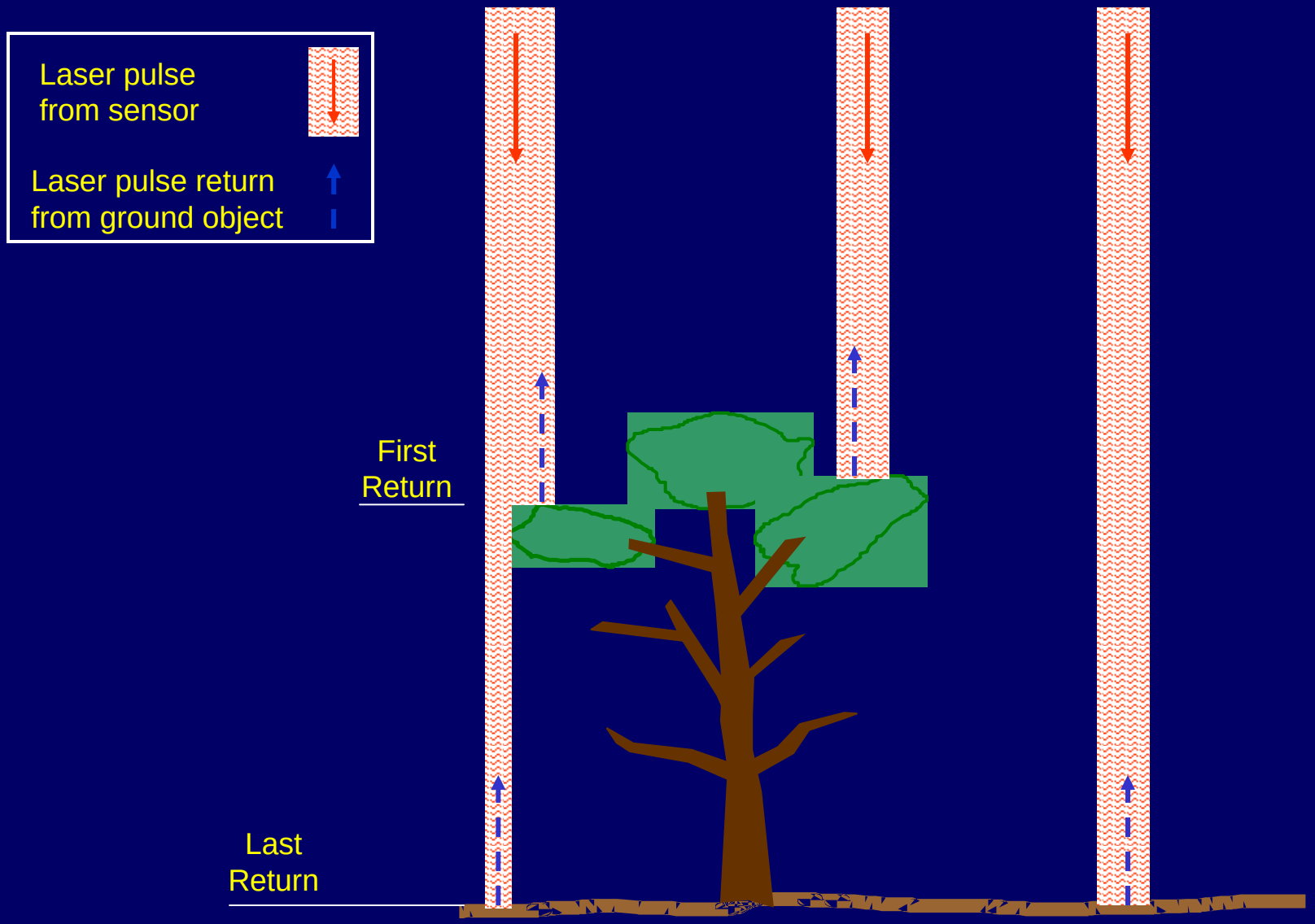


Source: Spencer B. Gross inc.

Vertical component of LIDAR returns



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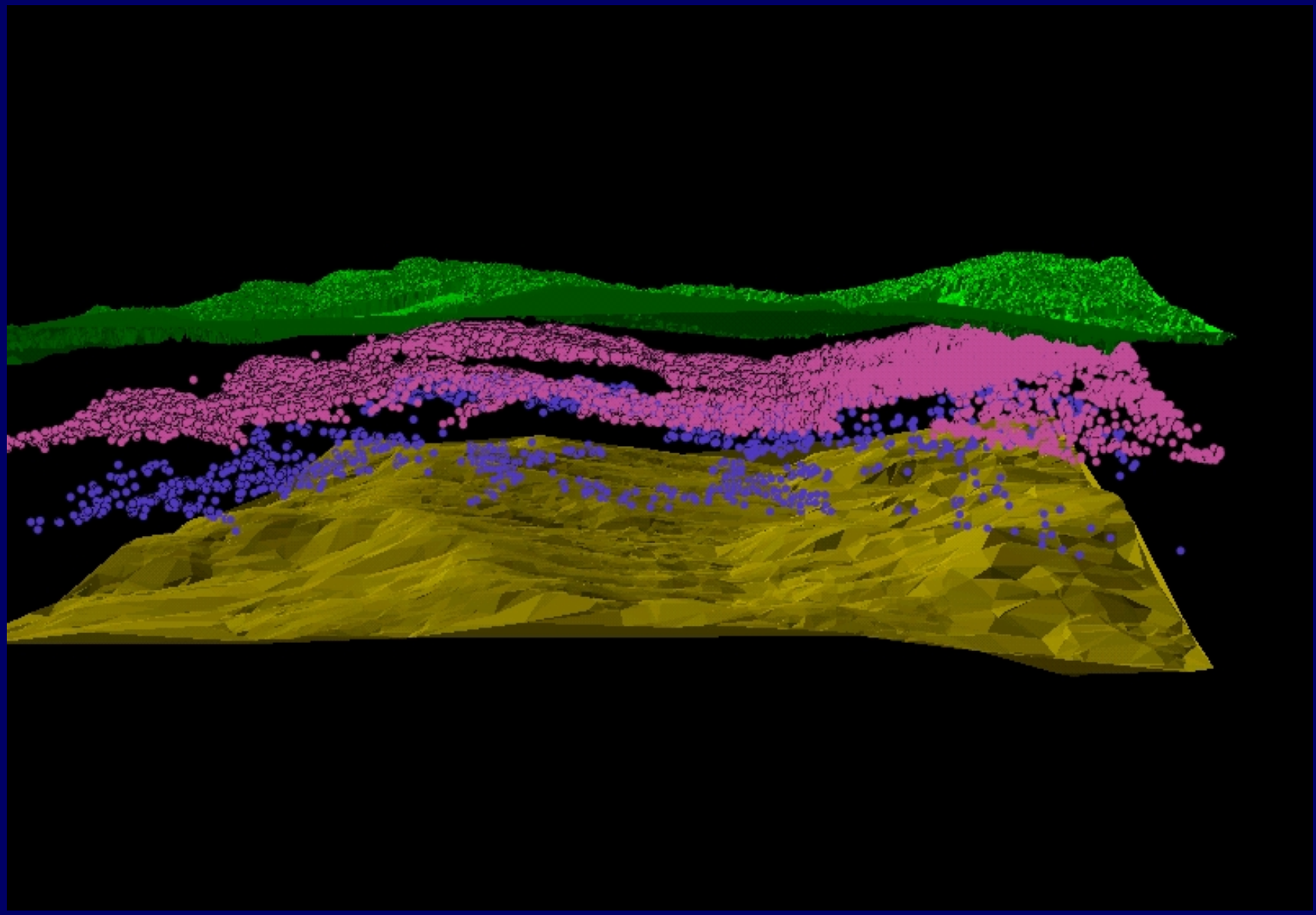
Verticality



Source: Spencer B. Gross inc.

Characterizing LIDAR Data

- LIDAR returns are post-processed to generate multiple point data sets, such as:
  - Bare-Earth data (last return or topographic).
  - Canopy data (first return).
  - Intensity of return data (radiometry of return)
- LIDAR data are exported as simple ASCII X, Y, Z data-points.
- Now, we have portable geo-spatial data and … the ability to produce physical-based models.
- A few examples ….

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LIDAR Record Data Format

X, EASTING (in Feet)	Y, NORTHING (in Feet)	Z, ELEVATION (in Feet)	R, LAST RETURN INTENSITY
349818.65000	4353997.60000	123.80000	5.10000
349842.57000	4353997.07000	124.58000	4.50000
349848.27000	4353993.43000	124.46000	6.60000
349846.86000	4353992.33000	124.58000	4.60000
349848.48000	4353993.13000	124.39000	7.90000
349896.74000	4353998.67000	128.28000	5.20000
349897.62000	4353998.26000	128.33000	5.90000
349898.57000	4353996.14000	128.29000	2.10000
349900.86000	4353994.10000	127.97000	1.70000
349899.02000	4353993.18000	127.97000	5.80000
349898.59000	4353992.31000	127.78000	5.30000
349900.07000	4353993.04000	127.98000	0.80000
349906.20000	4353996.07000	128.02000	7.10000
349907.63000	4353996.78000	128.03000	6.20000
349899.41000	4353990.04000	127.65000	3.30000
349885.91000	4353983.32000	126.92000	7.20000
349884.24000	4353982.48000	126.80000	7.50000
349886.22000	4353982.90000	126.96000	5.20000
349899.75000	4353989.60000	127.71000	3.40000
349908.46000	4353991.38000	127.98000	4.90000
349900.06000	4353987.19000	127.78000	2.80000
349881.73000	4353978.06000	126.68000	2.30000
349881.53000	4353977.38000	126.60000	0.90000
349893.63000	4353983.37000	127.28000	4.30000
349901.11000	4353987.07000	127.72000	1.80000
349907.27000	4353990.12000	127.89000	1.80000
349908.71000	4353990.83000	127.94000	7.10000
349910.32000	4353991.63000	127.85000	6.40000
349911.75000	4353992.33000	127.89000	7.90000

Source: The Center for Urban Environmental Research and Education (CUERE), U. of Maryland Baltimore County

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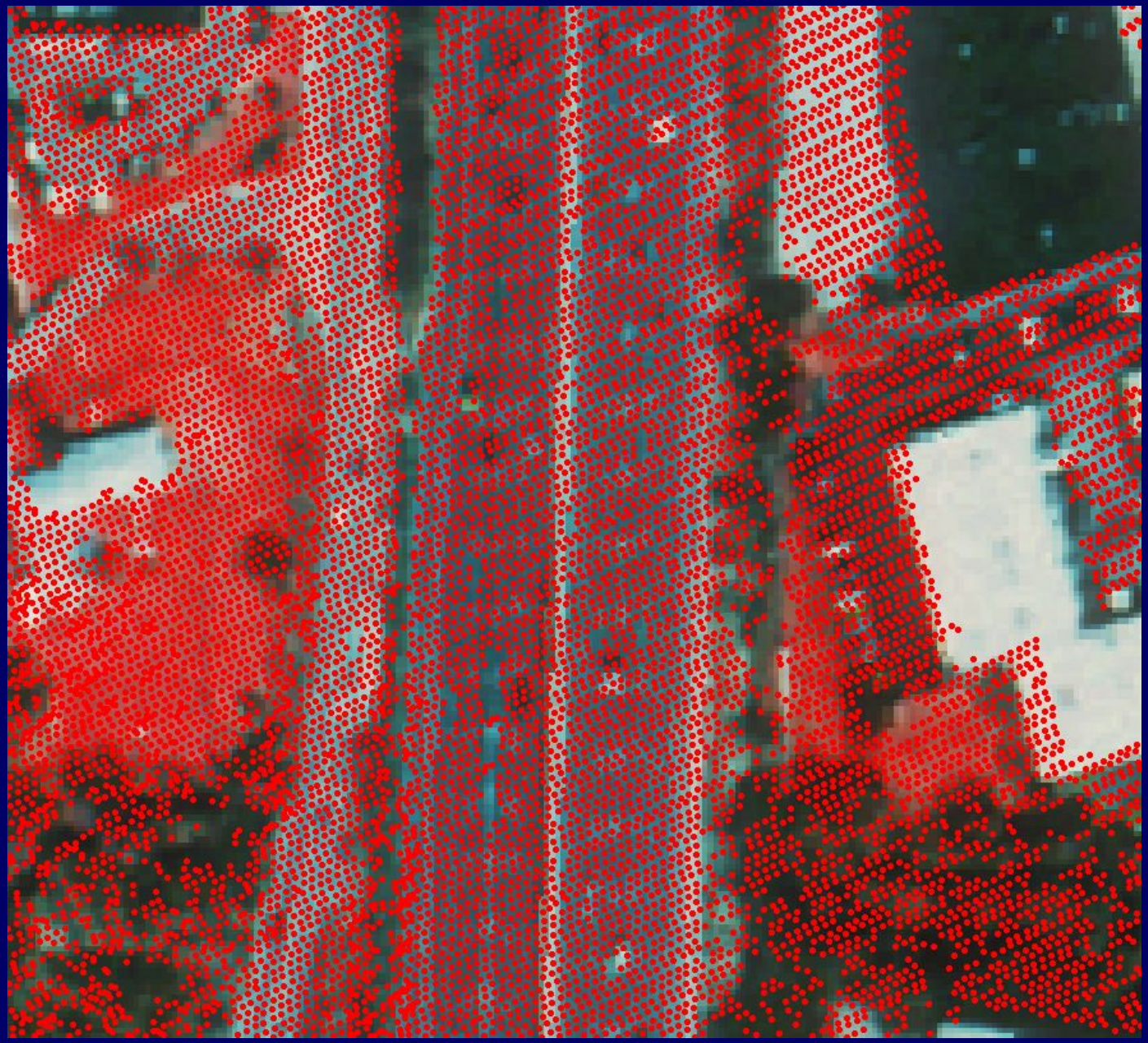
Bare-Earth LIDAR Points



Source: USGS, Digital Ortho Photo (Baltimore West Quad).

Ortho-image vs. DEM

Source: USGS, Digital Ortho Photo (Baltimore West Quad).

Source: The Center for Urban Environmental Research and Education (CUERE), U. of Maryland Baltimore County

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- **Bare-Earth** DEM within Dead Run subwatershed (Balt. County, MD.).
- 2’ DEM created from ~2.7’ LIDAR postings.
- Lines in red represent transects across streams.

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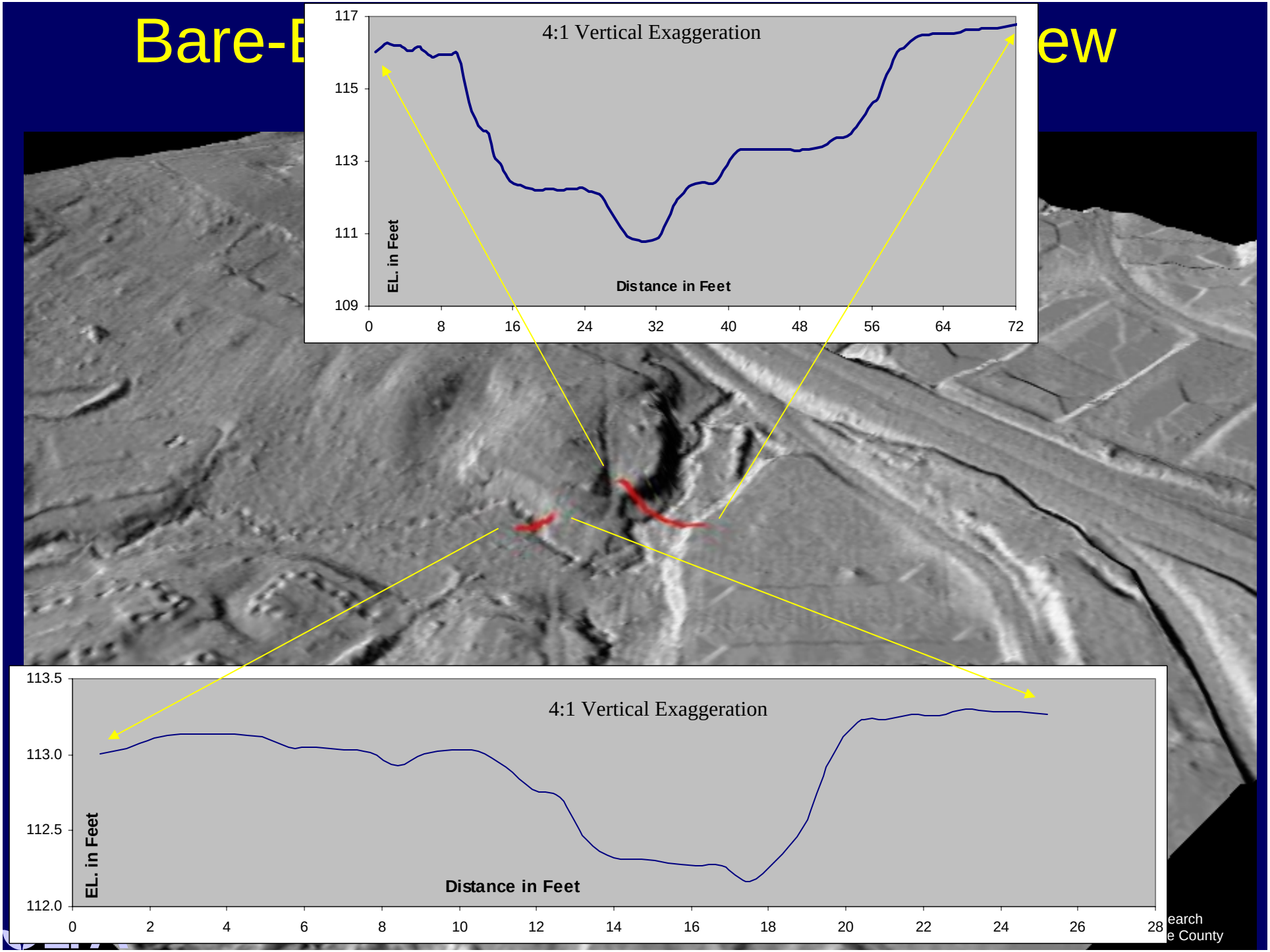
Source: The Center for Urban Environmental Research and Education (CUERE), U. of Maryland Baltimore County

Bare-E ew



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Bare-Earth LIDAR Intensity Data

1-meter LIDAR Intensity Data, Clarksburg Special Protection Area (CSPA).

Source: 1-foot color ortho-imagery courtesy of Montgomery County, Md.

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General Accuracy Standards of Topographic LIDAR

- Horizontal accuracy: ~ 1 meter.
- Vertical accuracy: ~ 15 – 60 cm.
  - Dependent upon slope and vegetation conditions (see Hodgson et al., 2003, *PE&RS*).

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The Promise of Topographic LIDAR

- Accurate, high-resolution, terrain model that can drive hydrologic prediction models, at multiple scales.
- Aid in the pre-development risk assessment of stream channels.
- Identification of subtle terrain / drainage features.
  - Depressional Wetlands, Vernal Pools, Side Channels.
- Provides a means to asses morphological change of stream channels and topography.
- “Whole-area” assessment vs. discrete field surveys.

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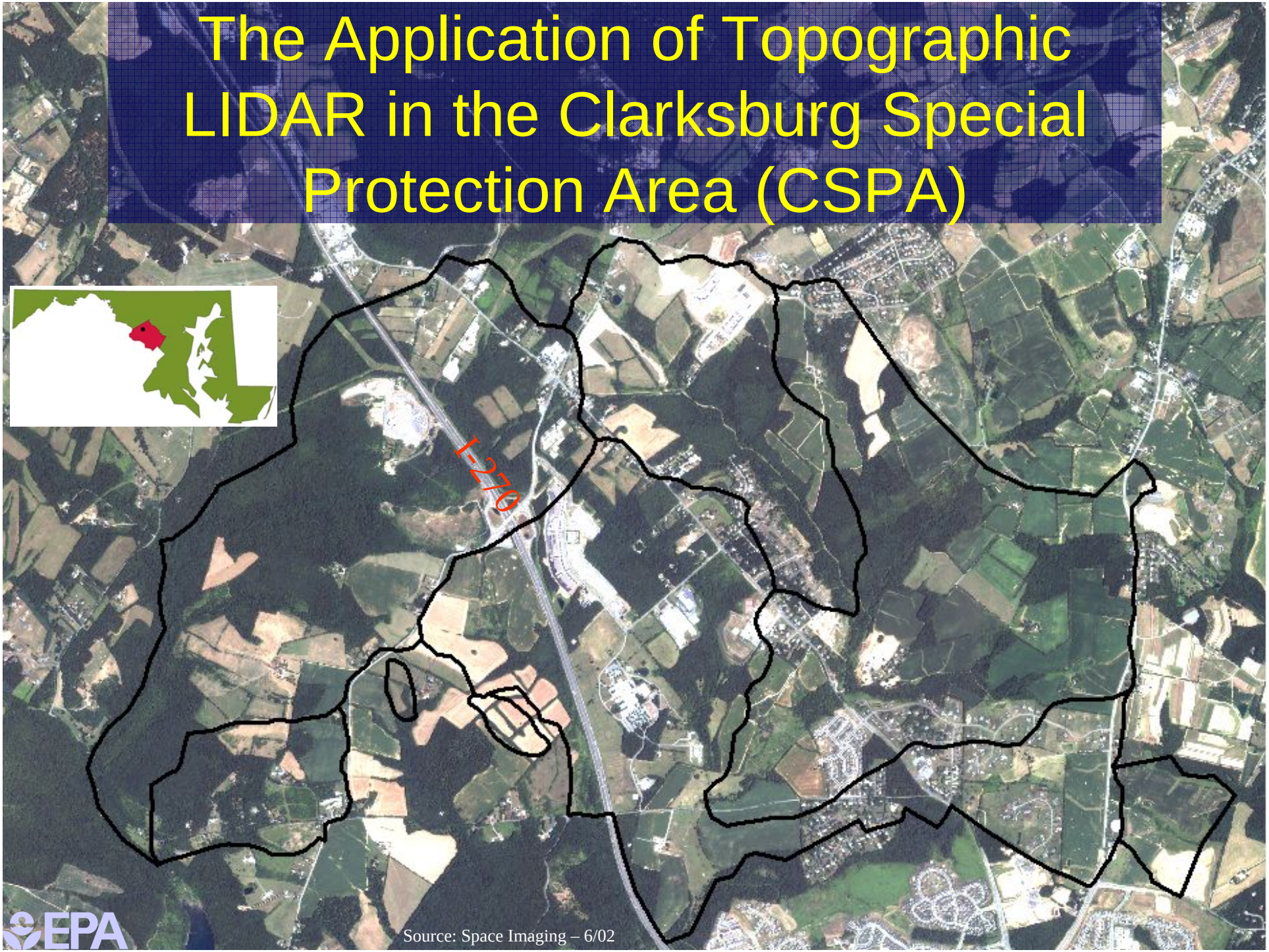
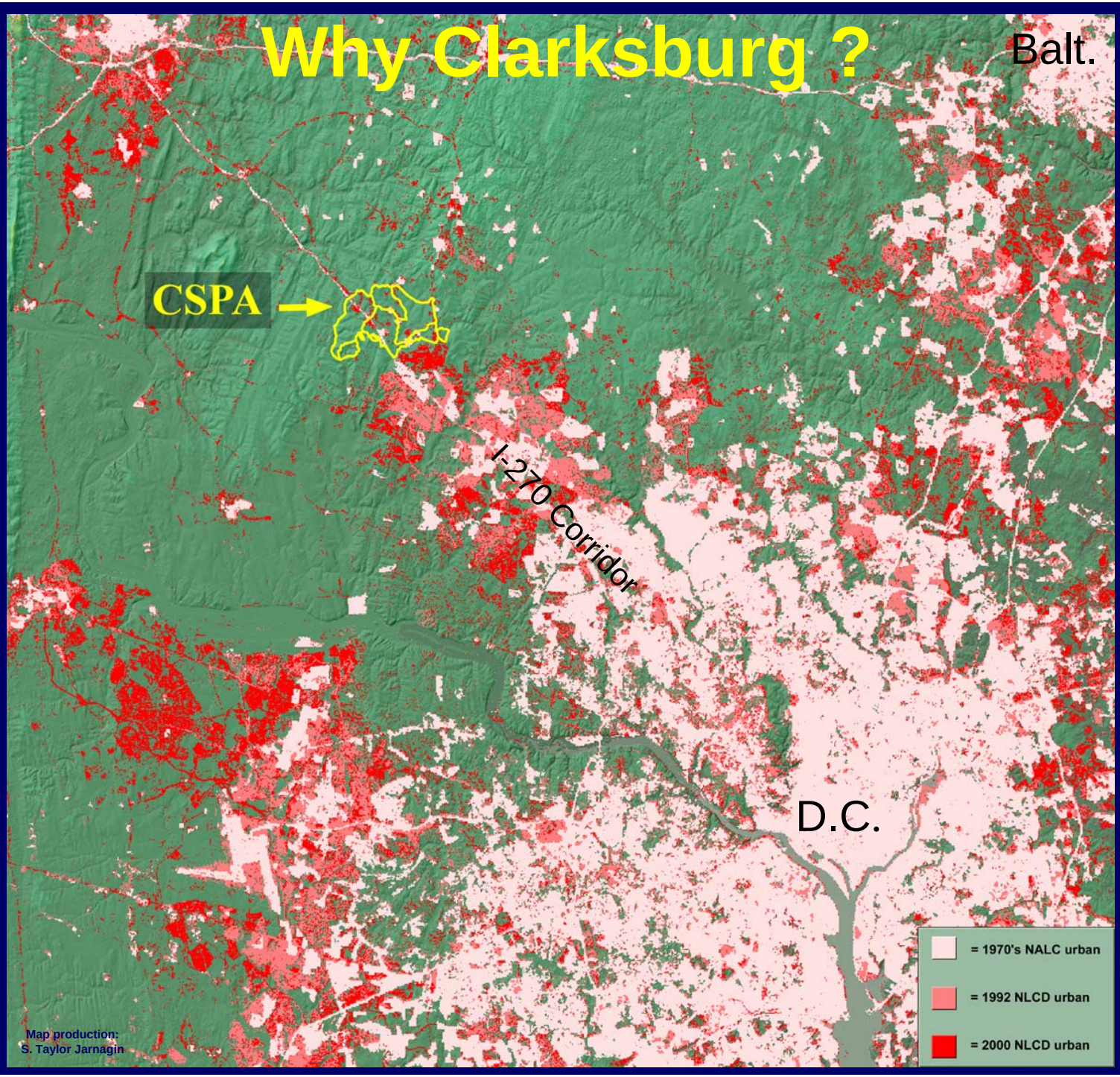
The Application of Topographic LIDAR in the Clarksburg Special Protection Area (CSPA)




Why Clarksburg ?
Balt.
CSPA
I-270 Corridor
D.C.
= 1970's NALC urban
= 1992 NLCD urban
= 2000 NLCD urban
Map production:
S. Taylor Jarnagin
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CSPA Research

- Environmental problem: Montgomery County, Md. requires an effective means to quickly and accurately assess the effectiveness of best management practices (BMPs) to mitigate the impacts of development on stream channels and landscape topography in the CSPA.

- Hypothesis: Repeat, high-resolution, LIDAR collects can effectively monitor morphological changes in stream channels and landscape topography.

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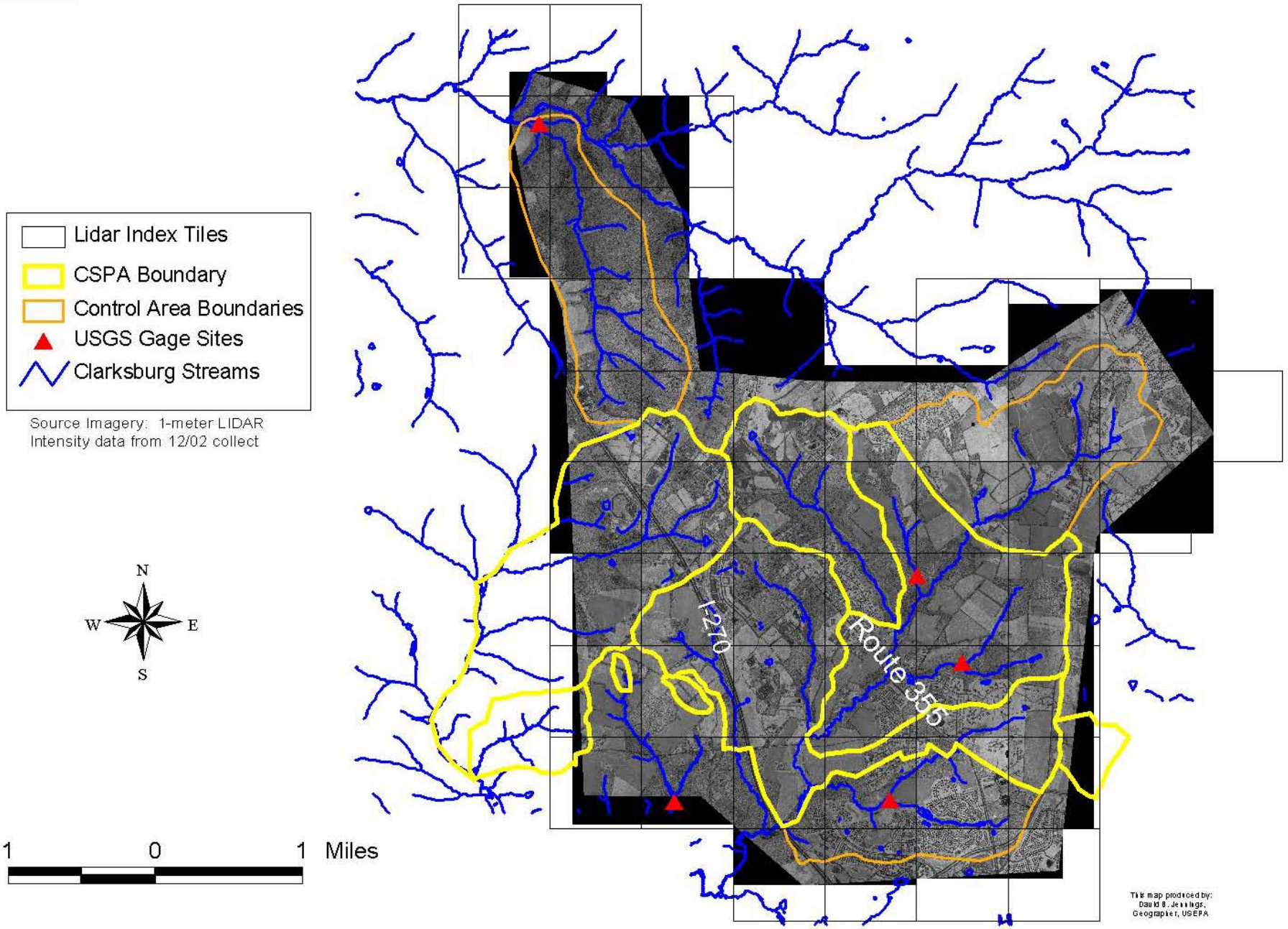
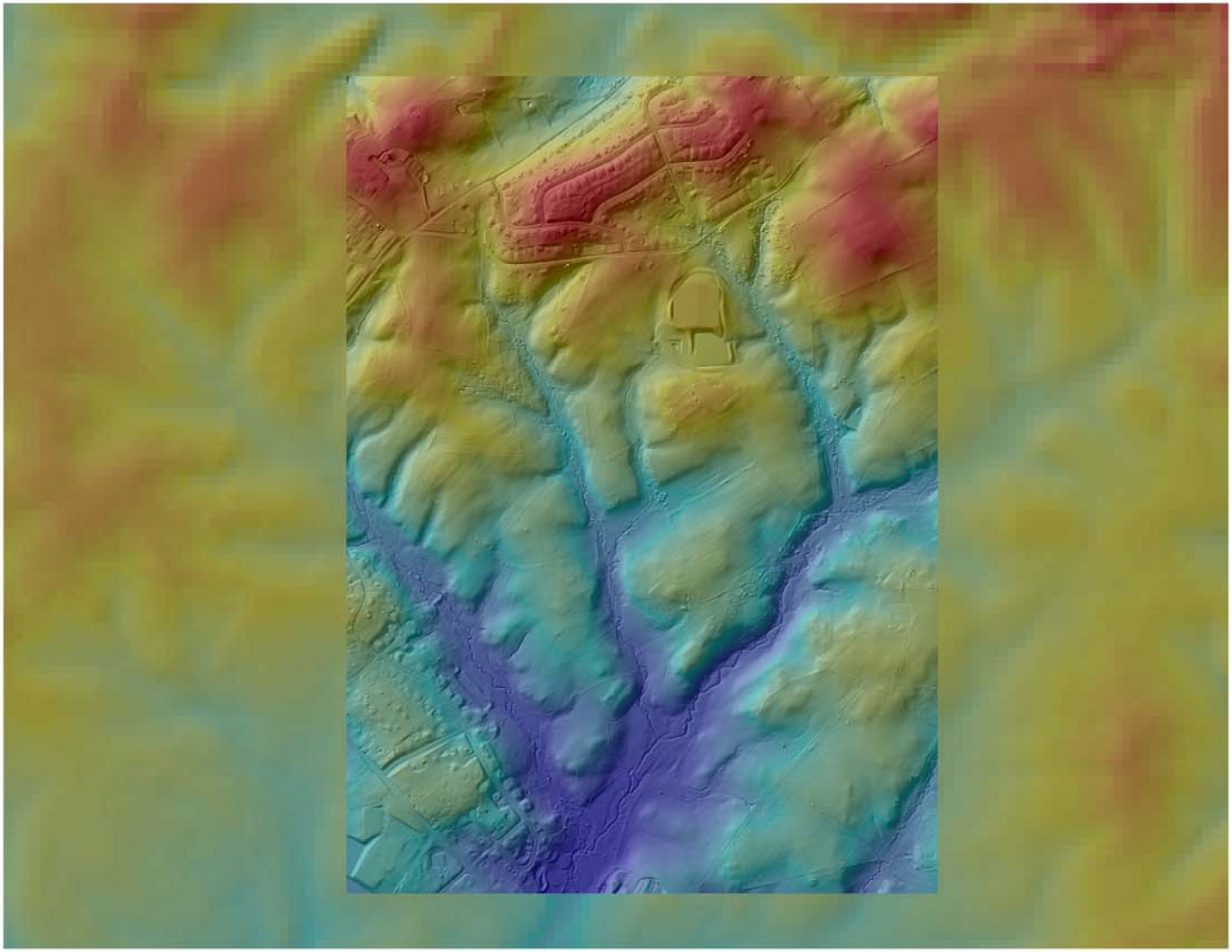
Clarksburg SPA Study Area



LIDAR 0.5m DEM vs.
National Elevation Dataset (NED) 30m DEM



Map production:
David Jennings and S. Taylor Jarnagin

0 0.5 1 Miles

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W E
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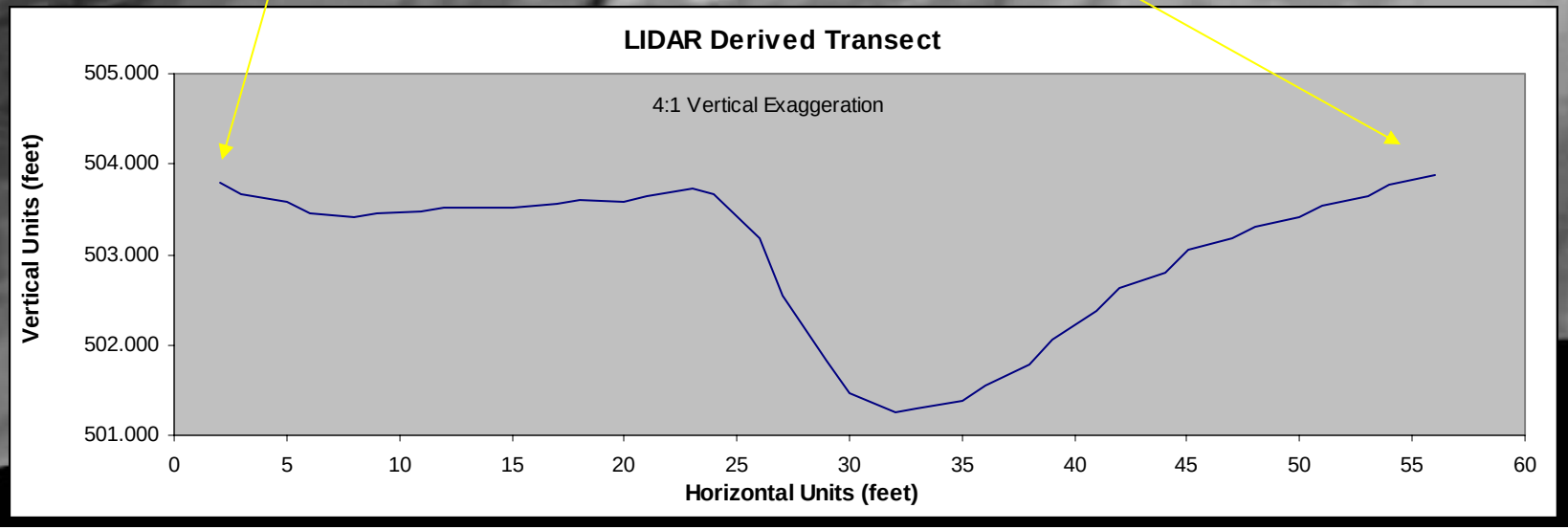
LIDAR Image
12/22/02

Ground Image
3/10/03



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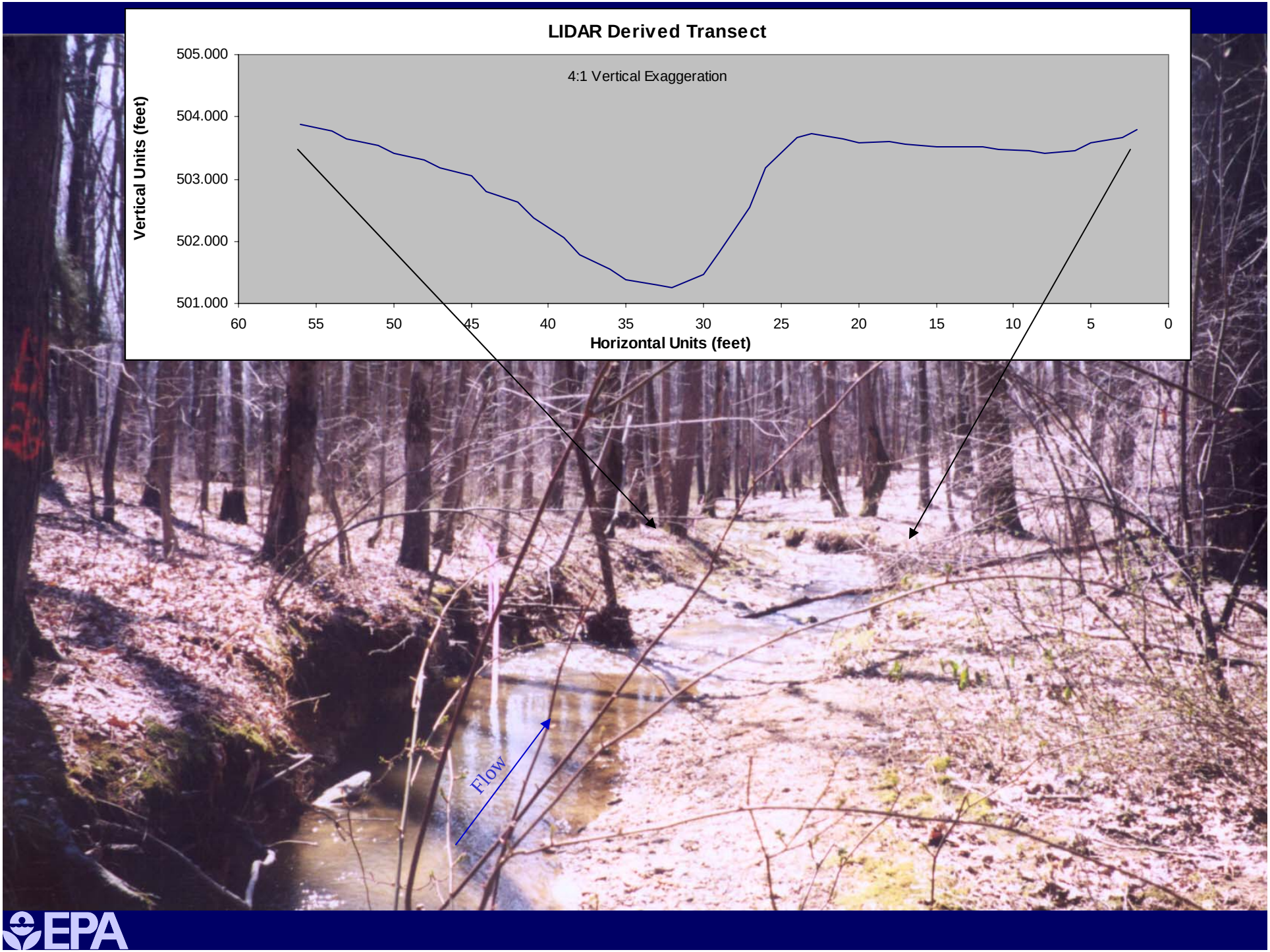
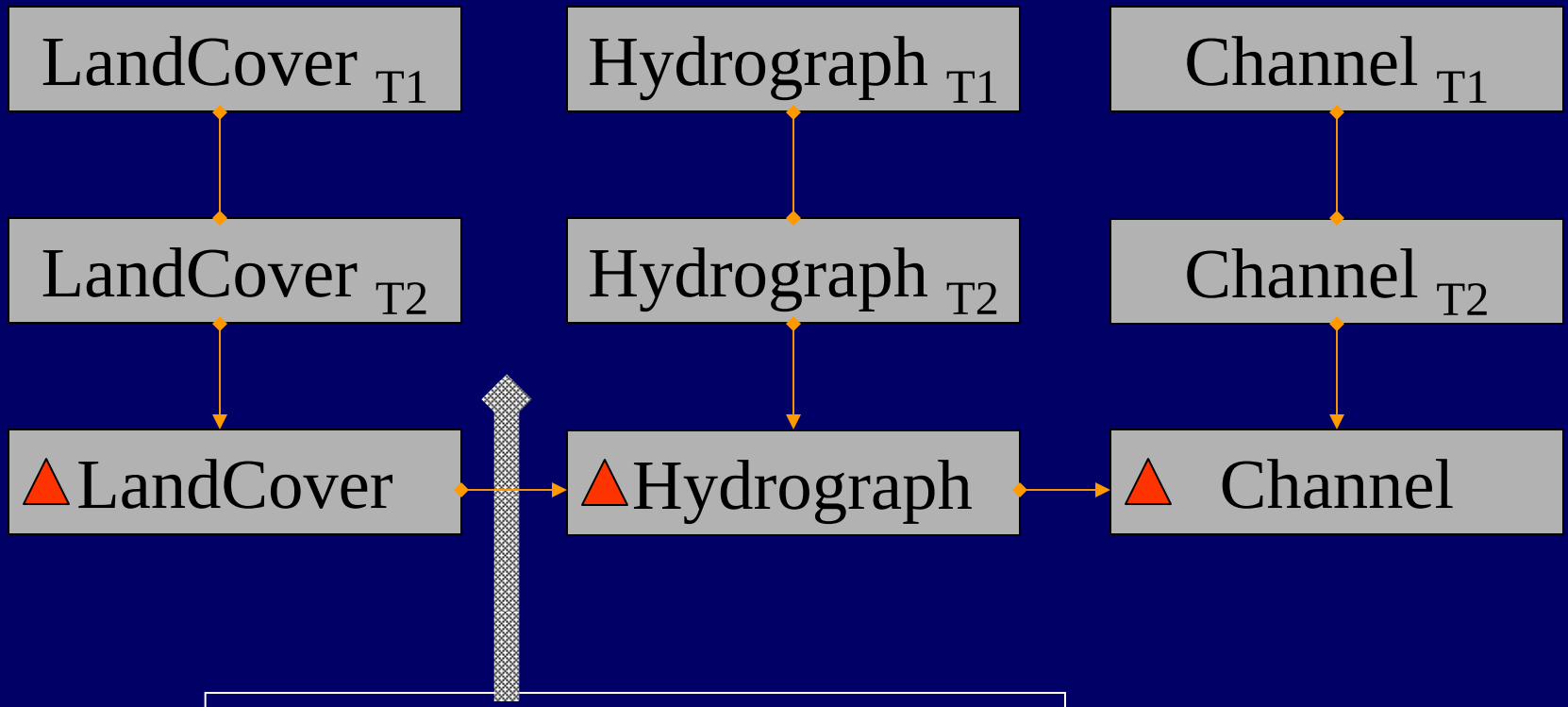

LIDAR Derived Transect
4:1 Vertical Exaggeration
Vertical Units (feet)
505.000
504.000
503.000
502.000
501.000
60
55
50
45
40
35
30
25
20
15
10
5
0
Horizontal Units (feet)
Flow

Relating Channel Change to Landscape Development



BMP mitigation

1. Maintenance of Landform and drainage Aspect.
2. Infiltration Zones.
3. Sand Filters.
4. Stormwater Ponds.

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Efforts to date in the CSPA

- First LIDAR collect, December/02.
- Second LIDAR collect, March/04.
- LU/LC change data for both periods collected.
- Four of Five USGS stream gauge stations in place.

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Partners

- Montgomery, County, Maryland, Dept. of Environmental Protection, Watershed Protection.
- The Center for Urban Environmental Research and Education (CUERE), U. of Maryland Baltimore County.